Successful Rehabilitation With Cochlear Implant in Post-irradiation Induced Hearing Loss in Nasopharyngeal Carcinoma Patient†

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Abstract

__Introduction__: We report a case of successful rehabilitation of hearing with a cochlear implant in a patient with nasopharyngeal carcinoma who developed post-irradiation hearing loss following treatment. __Clinical Picture__: A 55-year-old Chinese lady suffered from radiation-induced sensorineural hearing loss due to treatment for nasopharyngeal carcinoma. Audiological tests and imaging studies showed an intact retrocochlear pathway. __Treatment__: Cochlear implantation. __Outcome__: Cochlear implant was done with successful rehabilitation of hearing until the time of this report. __Conclusions__: If functionally active auditory fibres survive with no recurrent tumour, successful rehabilitation of post-irradiation induced sensorineural hearing loss is possible with a cochlear implant in a patient with nasopharyngeal carcinoma.

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Introduction

Nasopharyngeal carcinoma (NPC) is a common disease in Asia.[1] Radiotherapy is the mainstay of treatment. Following radiotherapy, complications like profound sensorineural hearing loss may occur. If functionally active auditory fibres survive and there are no signs of recurrent tumour, we believe that successful rehabilitation is possible with a cochlear implant. From the literature, there is only 1 case report of successful rehabilitation with cochlear implant in a patient who developed sensorineural hearing loss after radiotherapy. We report a case of successful rehabilitation with cochlear implant in a patient with nasopharyngeal carcinoma who developed post-irradiation sensorial hearing loss after treatment with radiotherapy.

Case Report

Madam LWL, a 55-year-old Chinese Cantonese lady, was diagnosed with NPC in August 1991. She presented for screening of NPC as her brother died of NPC. She was otherwise asymptomatic. Endoscopy of the nose and post-nasal space showed a tumour in the right fossa of Rosenmuller and a biopsy done was positive for NPC. Tumour stage was T2N0M0. She was started on radiotherapy, which was completed in November 1991.

During regular follow-up, she suffered troublesome hearing loss secondary to bilateral otitis media with effusion 3 months after radiotherapy. Bilateral myringotomy and Grommet tube insertion was done in February 1992 with improvement of hearing. However, her conductive hearing loss due to otitis media with effusion was recurrent after extrusion of grommets. Options of repeated grommet insertion, long-term grommet insertion or hearing aids were given. Hearing aid was chosen and used since July 1994.

She was noted to suffer from progressive bilateral sensorineural hearing loss since 1994, 3 years after radiotherapy. She managed fairly well until 2001 when the hearing loss became profound bilaterally (Fig. 1). She was distressed by the hearing loss and threatened suicide if she lost her hearing completely.

Cochlear implant as an alternative was discussed. Investigations were done to assess her suitability. Computed tomographic (CT) scan and magnetic resonance imaging (MRI) of the temporal bone showed intact cochlear and

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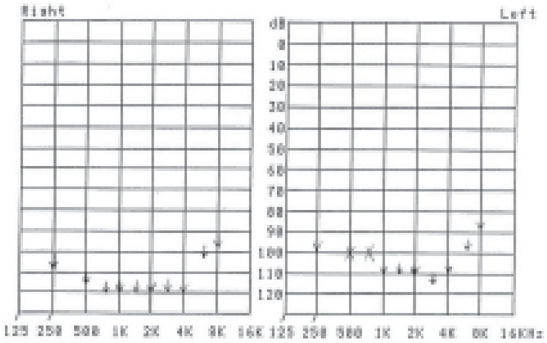

Fig. 1. Bilateral profound hearing loss.

cochlear nerves on both sides. In addition, CT showed changes in the skull base consistent with osteoradionecrosis (Fig. 2). There was fragmentation with sclerotic changes present at the skull base involving the clivus, occipital bone, both greater wings of sphenoid and the sphenoid sinuses. There was also opacification of both sphenoid sinuses and mastoid air cells. Infarct of the right pons was noted. Most importantly, there was no suggestion of tumour recurrence.

Audiological work-up with evoked response audiometry and electrocochleography were undertaken. Evoked response audiometry showed the right ear had no clear brainstem potentials seen using click stimuli at maximal intensity of 103 decibel (dB). The left ear showed response with poor repeatability at 103 dB. An electrocochleography showed the right ear had no response at maximal intensity of 103 dB, while the left ear had a response at intensity of 95 dB. Subsequently, decision was made to offer a cochlear implant for the patient.

A left cochlear implant was done because of better residual hearing. Also, the left side had less radiation as the nasopharyngeal carcinoma was on the right side. A pre-implant psychiatric assessment was supportive of her implantation. She was not suicidal and had no psychosis. Anticipated complications like less effective implant usage in case of lesser remaining spiral ganglion post-radiotherapy and poorer blood supply as a result of radiotherapy leading to impaired tissue healing were cautioned to the patient. Nucleus Implant model CI24M was used.

During the operation, multiple cholesterol granulomas were encountered in the sclerotic mastoid. There was light bleeding from the organised mastoid granulations. There was heavier bleeding from the thickened middle ear mucosa when this was cleared to expose the bone around the round window. The round window was difficult to visualise but once found cochleotomy was easily done. Insertion of the electrodes was smooth and full insertion was achieved. There was no intraoperative complication.

After the cochlear implant, wound healing was good without postoperative complications. All 22 electrodes were switched on 4 weeks after the surgery. The patient's response was reliable and consistent. Dynamic range obtained was 60 and T levels showed reverse sloping pattern from basal to apical channels. She was able to imitate non-verbal sounds like jingle bells and drumsticks. She was able to judge loudness on a scale of 5 and was comfortable with dynamic range of 65. She attended a few sessions of auditory verbal therapy after cochlear implant and later became a full-time user. There was improvement with speech understanding abilities during conversation with family members. Her lip-reading, articulation and quality of voice improved. She eventually was even able to communicate on the telephone. Since the cochlear implant, her mood improved.

Discussion

Side effects of radiotherapy on normal tissues of the head and neck are relatively common and often unavoidable. Cutaneous erythema, mucositis and xerostomia have been extensively reported in the literature. Beginning in the early 1960s, about 28 studies have examined effects of radiotherapy on 1627 patients. However, data on the sensitivity of the inner ear have been sparse or contradictory.

There are 2 main types of hearing loss after radiotherapy – conductive or sensorineural hearing loss.[2]

Conductive hearing loss occurs secondary to otitis media after radiotherapy. Ionising radiation may result in eustachian tube dysfunction, otitis media with effusion, or chronic otitis media with resultant conductive hearing loss.[3] This conductive hearing loss is often transient and reversible. Histological studies have shown that radiation induced a mucosal oedema that impairs eustachian tube patency and produces middle ear fluid collection.[4]

Post-irradiation sensorineural hearing loss is common but often ignored.[5] The reported incidence varies from no sensorineural hearing loss to 54% after radiotherapy.[6-9] This is commoner in older patients, with a 37% incidence in those over 50 years old.[10]

Post-irradiation sensorineural hearing loss may occur as a result of direct radiation injury to the brainstem[11] or obliterative endarteritis.[12] Sensorineural hearing loss occurred as early as 3 months after radiotherapy where 25% (<50 years old) had a deterioration of >10 dB at 4 kHz.[13] However, early hearing loss within 3 months was associated with significant recovery (>10 dB) at 2 years after irradiation in 40% of the ears. Post-irradiation sensorineural hearing loss occurs 0.5 to 1 year after treatment and is probably progressive.[5]

High-frequency sound is more susceptible to the harmful effects of radiotherapy.[13] At all intervals of follow-up, the

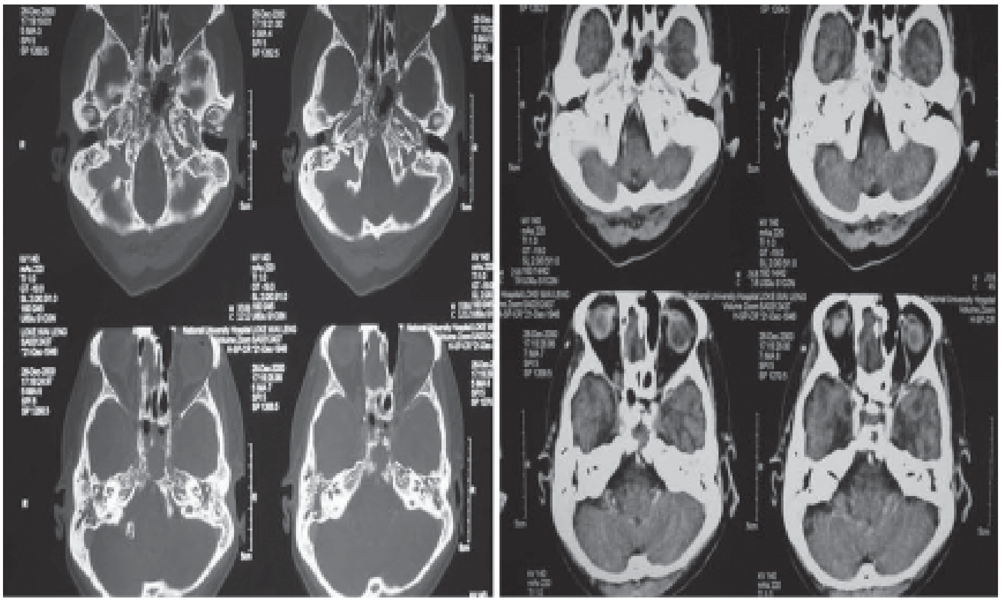

Fig. 2. CT scan temporal bone with intact cochlear and cochlear nerves.

mean deterioration expressed in decibels was always higher at 4 kHz than at pure tone average. One reason explained is that in the basal turn of the cochlea (which mediates high frequency sounds), the outer hair cells are arranged in 3 regular rows instead of 4 irregular rows in the apical turn. As a result, high-frequency sounds are represented by a smaller number of cells in the basal turn. Any insults to the cochlea would thus destroy proportionately more hair cells in the basal turn than the apical turn. This can also explain why high-frequency sound is more susceptible to all sorts of insults.[9]

There are factors in patients that indicate if they have a high risk of developing post-irradiation sensorineural hearing loss. These include the age and sex of the patient as well as the presence of post-irradiation secretory otitis media. Age and sex of patients were found to be independent prognostic factors for development of sensorineural hearing loss in a study by Kwong et al.[10] Twenty-nine per cent of males compared with 15% of females had persistent sensorineural hearing loss after radiotherapy. Older patients were more prone to develop persistent sensorineural hearing loss after radiotherapy. Persistent sensorineural hearing loss increased from 17% to 37% for patients 30 to 50 years old and more than 50 years old, respectively. Our patient is 55 years of age and falls into the older age group with increased risk.

It is unlikely secretory otitis media itself may result in sensorineural hearing loss per se. Development of secretory otitis media after radiation can be another manifestation of radiation damage and may indicate individual sensitivity to radiation. Patients with pre-existing hearing impairment before radiotherapy were not at higher risk of post-irradiation induced sensorineural hearing loss.[10] Our patient also suffered secretory otitis media indicating possible sensitivity to radiation.

Although many clinical studies have been done on post-irradiation sensorineural hearing loss, a diagnosis of radiation damage to the end-organ of hearing in the absence of supporting histological evidence should be made with caution. The temporal bone is relatively resistant to radiation insult unless the estimated dosage exceeds 65 Gy.[14] The organ of Corti is capable of resisting doses of radiation greatly in excess of those employed in conventional therapy.[15] Moreover, with choices of brachytherapy or stereotactic radiation, the chances of cochlear damage due to radiotherapy are further minimised. Other causes of hearing loss in patients who underwent radiotherapy like tumour spread, infection in the labyrinth and ototoxic damage should be excluded. A radiation dose of <30 Gy is recommended for hearing preservation[16,17] while a dose of >70 Gy caused hearing loss in all patients.[18] Our patient received a total of 60 Gy in 35 fractionations over 6 weeks indicating relatively high dosage of radiation and thus possible inner ear damage. From these 3 factors, we postulate that her sensorineural hearing loss is probably secondary to radiation injury.

Post-irradiation sensorineural hearing loss is a disabling condition. Cochlear implantation may be valuable in overcoming this problem. A case of a successful cochlear implantation in a patient with radiation-induced deafness was published in 1998.[19] The report involved a 67-year-old man with nasopharyngeal carcinoma who developed complete bilateral deafness due to labyrinthitis and radiation-induced neuritis of the acoustic nerve within 1 year after radiotherapy. A cochlear implant with a Combi 40 implant was used. Intraoperatively, the middle ear was found to be filled with thick and easily bleeding mucosa that indicated chronic inflammation. A dummy electrode was inserted to an insertion depth of 17 mm, but could not be advanced further. This was due to massive radiation-induced fibrous changes in the cochlear. Therefore, a short version of the Combi 40 that had 8 contacts distributed over a length of 11 mm was inserted. Telemetry testing indicated function of all 8 electrodes. There were no intraoperative or post-operative complications. Six months after implantation, the patient reported good detection of environmental sounds. Speech discrimination tests done 6 months after cochlear implantation showed 65% correct answers in the Freiburger numbers test and 25% in the Freiburger monosyllables test.

Our case revealed better results. Madam LWL was tumour-free for 10 years. Intraoperative findings were similar to this case but the insertion of electrodes of the implant was smooth and full with Nucleus Implant CI24M. When the implant was switched on, patient's response was good and she was able to talk on the telephone after the cochlear implant.

Conclusion

Radiotherapy is the mainstay of curative treatment in nasopharyngeal carcinoma. Post-irradiation induced complete sensorineural hearing loss is one of the important complications. Good outcome in rehabilitation with cochlear implant of post-irradiation induced hearing can be achieved.

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